DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] this invention -- a liquid crystal display -- starting -- especially -- highly minute -- many -- it is related with the liquid crystal display which has the high image display performance of display grace on a pixel screen
[0002]
[Description of the Prior Art] Many liquid crystal displays have come to be used as display day BAISU of a word processor or a personal computer taking advantage of the features, such as its thin shape and lightweight one, and a low power. Although the multi-digit (many pixels) display, the high definition display, etc. are demanded of the liquid crystal display used for such a display device, the active matrix type liquid crystal display attracts attention as a liquid crystal display which fills such a demand especially.
[0003] The principal part consists of two polarizing plates stuck one sheet at a time at the extroversion side side of the switching element array substrate which the above-mentioned active matrix type liquid crystal display made TFT the switching element, and was formed on the transparency insulating substrate, the opposite substrate by which opposite arrangement is carried out at this, the liquid crystal layer by which enclosure pinching is carried out in those substrate gaps, and a those switching element array substrates and an opposite substrate. In the active matrix type liquid crystal display of such structure, the incident light emitted from the light source prepared in the tooth back etc. passes the 1st polarizing plate, and carries out incidence to an opposite substrate side, and further, by the liquid crystal layer, the light rotates the polarization direction, passes to an array substrate side, passes the 2nd polarizing plate, and turns into display light. Only the light which penetrated the liquid crystal layer which is the pixel of the portion to which liquid crystal driver voltage was impressed at this time rotates the polarization direction, passes the 2nd polarizing plate, and will be in a lighting state. Or it is also a thing using the reverse operation. Anyway, a liquid crystal display has lighting / astigmatism LGT of a pixel controlled by polarization operation of such a liquid crystal layer.
[0004] In such a conventional active matrix type liquid crystal display, since the substrate of both a switching element array substrate and an opposite substrate is made to penetrate the light by which incidence is carried out from the light source and the picture is displayed, it is necessary for each to use the substrate of the high insulating transparency of glass, a quartz, etc. as both these substrates. Moreover, the same is said of a polarizing plate.
[0005]
[Problem(s) to be Solved by the Invention] By the way, as mentioned above, recent years require improvement in detailed-izing of the switching element of a pixel portion, and a high-speed response characteristic especially, in order to realize highly-minute-izing and many pixel-ization of a liquid crystal display.
[0006] Since shading nature is high (it is opacity) and it is hard to penetrate light source light in the active matrix type liquid crystal display of structure which was mentioned above, the silicon-single-crystal substrate for forming the transistor element used as a switching element cannot be used in practice. Thus, there is a problem that the silicon single crystal for aiming at further improvement in a switching characteristic cannot be used.
[0007] Moreover, the temperature rise of the whole liquid crystal display panel is caused further, and there are a substrate of the extroversion side of a switching element array substrate or an opposite substrate on which it is stuck since this polarizing plate absorbs about 50% of an incident light as heat energy theoretically, although it is necessary to arrange a polarizing plate so that the whole surface may be worn mostly (attachment), and a problem of a liquid crystal display panel that degradation of a liquid crystal layer etc. is promoted. Or there is a problem of becoming the cause which deviation produces in operation of a liquid crystal display panel by the temperature rise.
[0008] Moreover, since two substrates use the transparency substrate, the light source light which carries out incidence from the rear face (field where the light source has been arranged) of a substrate reflects by the direct or substrate interface, incidence is carried out to a TFT switching element, it becomes the cause of the optical leakage current of a switching element, and the applied-voltage maintenance property in a liquid crystal cell deteriorates, consequently there is a problem that a contrast ratio falls.
[0009] Although preparing the shading film called black matrix is also proposed in order to prevent generating of this optical leakage current, there is a problem of detailed-ization of patterns, such as a fall of a pixel effective-area product, TFT, and wiring, becoming difficult by establishing such a black matrix, and becoming the hindrance of highly-minute-izing or the formation of many pixels.

[0010] what was accomplished in order that this invention might solve such a problem -- it is -- the purpose -- highly minute -- many -- it is in having a pixel screen and an image display performance offering a good liquid crystal display
[0011]
[Means for Solving the Problem] In order to solve the above-mentioned technical problem, the liquid crystal display of this invention Two or more scanning lines to which a scanning pulse is impressed, and two or more signal lines to which the aforementioned scanning line is intersected, it is arranged and video-signal voltage is impressed, The pixel electrode arranged for every intersection of the aforementioned scanning line and the aforementioned signal line, The switching element which performs switching operation which impresses the aforementioned video-signal voltage to the aforementioned pixel electrode when it connects with the aforementioned pixel electrode, the aforementioned scanning line, and the aforementioned signal line and a scanning pulse is impressed The switching element array substrate which it had on the substrate, In the liquid crystal display equipped with the opposite substrate which is an opposite substrate equipped with the counterelectrode on the transparency substrate, and it has a gap, opposite arrangement is carried out between the pixel electrode of the aforementioned switching element array substrate, and the aforementioned counterelectrode, and the circumference is closed, and pinches a liquid crystal layer in the aforementioned gap It is characterized by providing light guide ****** which flows through light in parallel to the aforementioned substrate side of the aforementioned switching element array substrate, and leads this light to the aforementioned pixel electrode.
[0012] in addition -- as the material of above light guide ****** -- SiOx, SiNx, and Ta 2O5 etc. -- it can use suitably Since they is a material generally used also as a transparent insulator layer etc. in a liquid crystal display, its process adjustment in the manufacturing process of a liquid crystal display is good, and since such material mentioned as an example can perform the manufacture simply when using as a material of light guide ****** concerning this invention, they is desirable. Or in addition to this, it is transparent, and if it is a good material of light guide nature, it can use suitably as a material of above light guide ******.
[0013] Moreover, about the thickness of above light guide ******, various optimal thickness should differ corresponding to conditions, such as a size (pixel size) of the material used for light guide ******, and a pixel electrode, and pixel brightness required in order to perform good image display. for example, pixel size -- comparatively -- large -- high -- the case where a brightness light is needed -- light guide ****** -- thick -- carrying out -- the -- high -- what is necessary is just to enable it to introduce the light of an amount corresponding to a brightness light into the pixel section
[0014] moreover -- as the switching element of the above when the substrate for forming a switching element in the upper surface is formed for example, from the single crystal Si -- especially -- highly minute -- many -- in order to realize the high image display performance of the display grace of a pixel screen, the transistor element equipped with the barrier layer which consists for example, of a single crystal Si is suitable Or in addition to this, mobility can use suitably the element which has a high switching characteristic with good high-speed responsibility. At this time, the single crystal Si substrate as a material which forms the barrier layer which consists of the above single crystals Si can be suitably used as a substrate of a liquid crystal display, if the technology of this invention is applied even if (even if it is opacity), even when the permeability of light is not good.
[0015]
[Function] In the liquid crystal display concerning this invention, the optical-waveguide layer which draws light source light in parallel to this substrate on the substrate side of a switching element array substrate is prepared, and light source light is led to each pixel using this optical-waveguide layer. Without being limited to a transparency substrate like before as a substrate used for a switching element array substrate by this, it can also become possible to use the silicon-single-crystal substrate of shading nature, the switching element which forms the transistor element which used this silicon single crystal for the barrier layer, and has a good switching characteristic can be formed, and, as a result, a liquid crystal display with a good image display property can be realized.
[0016] Moreover, since it becomes unnecessary to prepare so that the light source and a polarizing plate may wear the whole principal plane simultaneously surface of a liquid crystal display panel like before since light can be drawn by the above optical-waveguide layers, and it becomes unnecessary to touch the substrate, problems resulting from heat absorption of a polarizing plate, such as a temperature rise of a liquid crystal display panel and degradation, are solvable. And the endurance of a liquid crystal display panel and reliability can be raised.
[0017] Moreover, it is at the former. Since the transparency substrate was used for both two substrates and incidence of the light source light was carried out from the substrate rear face That from which the light source light which carries out incidence from a substrate rear face reflected by the interface of a substrate etc. directly or indirectly, carried out incidence to the switching element, and caused an optical leakage current of a switching element The light which carries out incidence to a switching element can be prevented without preparing shading films, such as a black matrix, since light source light is introduced into the pixel through an electric optical-waveguide layer according to this invention, and the incidence to the switching element of light leading to an optical leakage current can be prevented. therefore, a black matrix etc. -- it is not necessary to prepare -- becoming -- highly-minute-izing and the formation of many pixels -- or detailed-ization of TFT etc. is realizable
[0018] Moreover, although it originated in static electricity charged in a glass substrate by using a glass substrate and the electrostatic discharge had arisen in the switching element conventionally, according to this invention, also using a shading nature substrate comes out. In this case, if for example, not a glass substrate but Si single crystal substrate is used, electrification in a substrate can be avoided by the conductivity of the Si single crystal substrate, and the electrostatic discharge of TFT resulting from electrification of a substrate can be prevented.

[0019]
[Example] Hereafter, the example of the liquid crystal display concerning this invention is explained in detail based on a drawing.
[0020] Drawing 1 is a liquid crystal display concerning this invention. It is drawing showing the structure of a 1-pixel portion. The single crystal Si substrate 1 which this liquid crystal display becomes from single crystal silicon (single crystal Si) as a shading nature substrate as shown in drawing, The 1st buffer layer 2 formed so that the whole single crystal Si substrate 1 up simultaneously surface might be worn, The optical-waveguide layer 3 formed on the 1st buffer layer 2, and the 2nd buffer layer 4 formed so that the whole substrate simultaneously surface containing the optical-waveguide layer 3 might be worn, The gate electrode layer 5 furthermore formed on the 2nd buffer layer 4, using the 2nd buffer layer 4 as a gate insulating layer, Drain 6a formed in the front face of the single crystal Si substrate 1, and source 6b, The 1st layer insulation layer 7 formed in the upper layer so that they might furthermore be covered, The metal wiring layer 8 connected to drain 6a, and the 2nd layer insulation layer 9 formed so that the whole substrate simultaneously surface top containing these might be covered, From the pixel electrode 10 which was connected to source 6b and formed in the portion corresponding to a pixel field, the outline of the structure of the switching element array substrate 11 is formed.
[0021] In the switching element array substrate 11, the single crystal Si transistor element using single crystal Si substrate 1 the very thing of the field which was equipped with drain 6a, source 6b, and the gate electrode layer 5, and was pinched between drain 6a and source 6b by making the 1st buffer layer 203 into a gate insulator layer as a pixel section switching element as a barrier layer is formed. Moreover, a pixel field is formed in the portion covered by the pixel electrode 10, and the light source light supplied by the optical-waveguide layer 3 to the pixel field from the light source (it sets to drawing 1 and is an illustration ellipsis) is drawn. And as shown in the arrow 12 of drawing 1 , outgoing radiation of the drawn light source light is carried out in the direction of a normal of the flat surface of the switching element array substrate 11. And it becomes the display light of a screen through the liquid crystal layer 202 and the opposite substrate 200. Transparency of the transmitted light is controlled by the state of the liquid crystal layer 202 in the path penetrated at this time, and the state of lighting / astigmatism LGT of a pixel like the usual liquid crystal display is controlled by it.
[0022] Here, in order to make an optical waveguide property good, it forms so that it may reach 1st buffer-layer 2 to the refractive index of the optical-waveguide layer 3 and the refractive index (optical refractive index) of the 2nd buffer layer 4 may become high.
[0023] It is desirable for a light transmittance to use a good material of the process adjustment in a liquid crystal display highly as a formation material of the optical-waveguide layer 3. Specifically, they are SiOx used also as a transparent insulator layer, SiNx, and Ta 2O5. It can use suitably. Moreover, as for the thickness of each class, it is desirable to set it as a suitable value about the optical-waveguide layer 3 corresponding to the quantity of light of the light source light to draw, and it is desirable to set up so that it may also become the suitable value which reaches 2nd buffer-layer 4 again and is demanded as a gate insulating layer about the thickness of the 1st buffer layer 2.
[0024] this example -- as the thickness of the optical-waveguide layer 3 -- 300 as the thickness of [nm] and the 1st buffer layer 2 -- 100 the [[nm] and] -- as the thickness of the 2 buffer layer 4 -- 400 It was set as [nm], respectively.
[0025] Moreover, it was referred to as 0.625 [mm] as basis board thickness of the single crystal Si substrate 1. As a material of this single crystal Si substrate 1, it is a diameter 125 [about]. The single crystal Si substrate of basis board thickness 0.625 [mm] was used by the round shape of [mm].
[0026] Moreover, as a gate electrode layer 5, a polycrystal Si film is used and it is 500. It formed in the thickness of [nm]. Moreover, formation of drain 6a and source 6b was performed by forming the single crystal Si substrate 1 into low resistance by the ion implantation method.
[0027] Drawing 2 is drawing showing the outline of the overall structure of the liquid crystal display of this invention. It has a gap in the above-mentioned single crystal Si substrate 1, and opposite arrangement of the opposite substrate 200 is carried out, a spacer-cum-the sealing agent 201 is formed in the circumference of both those substrates, the gap is held, and the liquid crystal layer 202 is enclosed and pinched by the gap. Thus, opposite arrangement of the opposite substrate 200 and the switching ** array substrate 11 is carried out, the liquid crystal layer 202 is pinched by the gap, and the principal part of the liquid crystal display panel 203 is constituted. And in order to impress liquid crystal driver voltage to this liquid crystal display panel 203, the liquid crystal drive circuit 204 is arranged.
[0028] Moreover, in order to supply the light source light supplied from the light source 205 to the optical-waveguide layer 3, the optical-transmission system 206 is formed, and the polarizing plate 207 is stuck on the end face of the optical-transmission system 206. The aforementioned light source 205 is arranged at the background of this polarizing plate 207.
[0029] Thus, the light source light 208 supplied from the light source 205 receives polarization through a polarizing plate 207, is further drawn by the optical-transmission system 206, and is supplied to the optical-waveguide layer 3. Furthermore, it is mostly led in parallel with the switching element array substrate 11, and each pixel field is supplied by the optical-waveguide layer 3.
[0030] Even if the substrate which consists of a high Si single crystal of shading nature as a single crystal Si substrate 11 by considering as the above structures is used for the liquid crystal display of this invention, it can display a picture using light source light. And since you can use a single crystal Si substrate in this way, the single crystal Si can be used for a barrier layer, and a switching element can be formed, and let the operating characteristic, especially high-speed responsibility be good things.
[0031] Moreover, since a polarizing plate 207 is formed in the horizontal position of the liquid crystal display panel 203 and the need of preparing in the field near the light source 205 (it sticking) is lost as shown in drawing 2 , the temperature rise of the liquid crystal display panel 203 by heat absorption of a polarizing plate can be canceled, and improvement in the reliability and

endurance can be aimed at. Moreover, since it becomes unnecessary for that from which the thickness of the liquid crystal display panel 203 increased, and only the thickness of the light source 205 had become the hindrance of thin-shape-izing of a liquid crystal display panel at least since the light source 205 was formed in the tooth back of a liquid crystal display panel in the conventional liquid crystal display to form the light source 205 in the tooth back of the liquid crystal display panel 203 according to this invention, thin shape-ization of the liquid crystal display panel 203 can be improved further.

[0032] Moreover, since the single crystal Si substrate 1 used by this example is a substrate which consists of a good single crystal Si of shading nature, it can interrupt the incident light from this single crystal Si substrate 1 side, and can prevent the malfunction by the optical leakage current of a switching element.

[0033] Moreover, in the conventional liquid crystal display, in the liquid crystal display of this invention, since what used the substrate in which static electricity like a glass substrate as a substrate of the switching element array substrate 11 tends to be charged can also use the single crystal Si substrate 1 which consists of single crystal Si material as mentioned above, it can prevent electrification of static electricity like before, and can prevent the electrostatic discharge of a switching element.

[0034] Next, the formation method of the liquid crystal display of this invention, especially the portion of an optical-waveguide layer is explained as a center.

[0035] First, it is the low oxide film of a refractive index from the optical-waveguide layer 3 behind formed as the 1st buffer layer 2 on the single crystal Si substrate 1 as shown in drawing 3 (a). 100 [nm] formation is carried out. As a single crystal Si substrate 1, it is diameter abbreviation here. Si substrate of the round basis board thickness 0.625 [mm] of 125 [mm] was used.

[0036] Next, as shown in drawing 3 (b), it is an oxide film with a refractive index higher than the 1st aforementioned buffer layer 2 as an optical-waveguide layer 3 on the 1st buffer layer 2 300 It forms in the thickness of [nm]. In order to obtain such a refractive index, the impurity of diacid-ized germanium was added to the material used as the basis of the optical-waveguide layer 3 at the time of membrane formation of the optical-waveguide layer 3. If it was suitably used as a formation material of this optical-waveguide layer 3 and material was carried out, as it mentioned above, they are SiOx, SiNx, and Ta 2O5. It can use.

[0037] Then, as shown in drawing 3 (c), it is the again same low oxide film of a refractive index as the 1st buffer layer 2 as the 2nd buffer layer 4 on the optical-waveguide layer 3 400 [nm] formation is carried out. And this oxide film is processed according to a photo etching process, and the 2nd buffer layer 4 is formed. The 1st buffer layer 2, the optical-waveguide layer 3, and the 2nd buffer layer 4 are formed in this way, and an optical waveguide is obtained. Moreover, it reaches 1st buffer-layer 2 and the gate insulating layer of the transistor for switching is formed of the 2nd buffer layer 4.

[0038] Since the rate of an optical refraction to the light source light of the above-mentioned optical-waveguide layer 3 reaches 1st buffer-layer 2 and is a high refractive index from the refractive index of the 2nd buffer layer 4 moderately, total reflection of the light source light which carried out incidence to the optical-waveguide layer 3 is carried out in respect of each field of the optical-waveguide layer 3, the 2nd buffer layer 4 and the optical-waveguide layer 3, and the 1st buffer layer 2, and the optical-waveguide layer 3 is mostly led to it with low loss horizontally with the switching element array substrate 11. And outgoing radiation of the light drawn for every pixel field is carried out in the direction of a normal (that is, direction shown by the arrow 12) to the switching element array substrate 11 (and pixel electrode 10) at the edge of the optical-waveguide layer 3.

[0039] Moreover, the 2nd buffer layer 4 also has conversely the function to intercept the light which carries out incidence toward optical-waveguide layer 3 grade from the exterior.

[0040] Then, as shown in drawing 3 (d), it is a polycrystal Si film 500 [nm] formation is carried out, this is processed into a predetermined configuration, and the gate electrode layer 5 is formed.

[0041] Next, as shown in drawing 3 (e), impurity ion is driven into the position of the single crystal Si substrate 1 by the ion implantation method, and drain 6a and source 6b are formed. And the single crystal Si substrate 1 whole is supplied to a heating furnace, and it is about 700. It is activated with a degree.

[0042] Next, it is 500 as shown in drawing 4 (f). The 1st layer insulation layer 7 is formed in the thickness of [nm]. And the contact hole which exposes drain 6a in this 1st layer insulation layer 7 is drilled. And in order to take electric contact to drain 6a, a conductive film like aluminum is formed, patterning of this is carried out and the metal wiring layer 8 is formed.

[0043] Next, it is the 2nd layer insulation layer 9 so that a these top may be covered, as shown in drawing 4 (g) 600 It forms in the thickness of [nm]. And shortly, a contact hole is drilled to the 2nd layer insulation layer 9, the 1st layer insulation layer 7, the 2nd buffer layer 4, and the 1st buffer layer 2 so that source 6b may be exposed. And it is a transparent electric conduction film like ITO, for example 200 It forms in the thickness of [nm], and patterning of this is carried out to the configuration corresponding to each pixel field, and the pixel electrode 10 is formed. At this time, the pixel electrode 10 is formed so that it may connect with source 6b through the aforementioned contact hole. Thus, the switching element array substrate 11 is formed.

[0044] And such a switching element array substrate 11 is combined with the opposite substrate 200 like the above-mentioned, the gap is made to enclose and pinch the liquid crystal layer 202, the liquid crystal display panel 203 is formed in it, and the liquid crystal display applied to this invention at this combining the liquid crystal drive circuit 204, the light source 205, the optical-transmission system 206, and polarizing plate 207 grade is completed.

[0045] The operating characteristic of the transistor for switching of the liquid crystal display of the above this examples is shown in drawing 5 (a). Moreover, the switching-operation property of the liquid crystal display using the conventional polycrystal silicon TFT (p-SiTFT) is shown in drawing 5 (b) as an example of comparison over this.

[0046] It turns out that mobility of the operating characteristic of the transistor for switching of the liquid crystal display concerning this invention is improving by leaps and bounds compared with it of the conventional liquid crystal display, and the good high operating characteristic of ON/OFF ratio is shown so that clearly also from this drawing 5 . This [be / because single crystal Si material was used for the barrier layer as a switching element / it] is clear.

[0047] In addition, in an above-mentioned example, although an example was shown about the case where it forms by the depositing method as the manufacture method of the optical-waveguide layer 3 (drawing 6 (a)), it can form also by the following manufacture methods.
[0048] That is, as shown in drawing 6 (b), by pouring impurity ion into the surface of a transparency substrate 601 like a glass substrate, the refractive index of the portion can be changed and the method of forming the optical-waveguide layer 3 can also be applied.
[0049] Or as shown in drawing 6 (c), the method of carrying out deposition formation of the 1st buffer layer 2, injecting impurity ion into the front face, and forming the optical-waveguide layer 3 on the single crystal Si substrate 1 is also applicable.
[0050] Or as shown in drawing 6 (d), a transparency substrate 601 like a glass substrate can be made to serve a double purpose also as the 1st buffer layer 2, and the method of forming the optical-waveguide layer 3 on it, and forming the 2nd buffer layer 4 on it further can also be applied.
[0051] Moreover, after forming the transistor element for switching on a substrate 1 first, you may make it form optical-waveguide layer 3 grade contrary to this order, although gate electrode layer 5 grade is formed and the transistor element for switching is formed in the above example, after forming optical-waveguide layer 3 grade on a substrate. In this case, on a transistor element, as the optical-waveguide layer 3 is piled up, it is formed, and there is also an advantage that the numerical aperture of a pixel can be improved further.
[0052] If it furthermore adds, in this invention, a transparency substrate like a glass substrate or a quartz substrate can also be used besides the single crystal Si substrate explained in full detail as the above-mentioned example.
[0053]
[Effect of the Invention] as mentioned above -- according to [as clearly shown by detailed explanation] this invention -- highly minute -- many -- it can have a pixel screen and a liquid crystal display with a good and image display performance and high reliability without a malfunction can be offered

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[Translation done.]